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Forage Production Potential and Economics of Maize (*Zea mays*) with Legumes Intercropping under Different Methods of Sowing

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ABSTRACT

A field experiment was carried out at Agricultural College Farm, Baptla, Andhrapradesh during *kharif* 2011 to select a suitable intercrop combination for fodder maize under different methods of sowing and to study the economics of this fodder based intercropping systems. Results of the experiment indicated that the treatment combination involving maize in pairs + cowpea produced the highest tonnage of green fodder (50.1 t ha^{-1}), dry fodder (14.2 t ha^{-1}), and drymatter of 9205 kg ha^{-1}. This combination also recorded the maximum gross return (28,448Rs ha^{-1}), net return (14,783 Rs ha^{-1}), and returns per rupee investment of 2.1. Among the legumes, cowpea was found to be the best intercrop for fodder maize.

Key words : Economics, Fodder maize, Green fodder yield, Intercropping, Legumes.

Livestock production is the backbone of Indian agriculture and source of employment in rural areas for centuries. This sector has been the primary source of energy for agricultural operations and major source of animal protein. India is house to 15 per cent of world cattle population and 16 per cent of human population to be sustained and progressed on 2 per cent of world's geographical area. The present context of shortage of nutritious forage coupled with heavy pressure on arable land for grain and commercial crops, it is not possible to increase the area under forage crops. Hence the availability of adequate fodder has the most critical bearing on the livestock production. The production potential of livestock is quite poor in India due to shortage of quality fodder. (Nyamagonda *et al*., 2002). Growing of fodder var. African tall maize with forage legumes and feeding of both cereal and legume forage to the livestock would result in improving animal health and livestock production with low input cost with efficient utilization of growth resources.

MATERIAL AND METHODS

The experiment was conducted during *kharif* season of 2011 at the Agricultural College Farm, Baptla. The experimental soil was sandy clay, having pH 7.6, medium in organic carbon (0.5%), low in available nitrogen (175 kg ha^{-1}), and high in available phosphorus (33.9 kg ha^{-1}) and potassium (532.5 kg ha^{-1}). A set of 10 treatment combinations involving maize and legumes, *viz*., cowpea, clusterbean and pillipesara, were taken as sole, mixed and paired in randomized block design with three replications. Forage maize cv 'Africantall' and forage legumes, viz, cowpea cv 'EC4216', pillipesara cv 'local',andclusterbean cv 'Bundel Guar 2' were sown in the first week of July. Fodder maize and fodder legume sole crops were sown at 45 cm x 10 cm whereas in paired row planting, 30 cm between rows in a pair and 60 cm between two pairs was followed. In mixed cropping, seeds of fodder maize and legume were mixed and sown in lines spaced at 45 cm. The seed rates for maize, cowpea, pillipesara and cluster bean were 50, 30, 40 and 25 kg ha^{-1} respectively. A uniform dose of nitrogen, phosphorous and potassium were applied as per the recommendation @120 kg N, 50 kg P_2O_5 and 40 kg K_2O ha^{-1} through urea, single superphosphate (SSP) and murate of potash (MOP) respectively to all the plots. The crops were harvested at 60 days after sowing.

RESULTS AND DISCUSSIONS

Growth characters

It was observed that the method of sowing & different legume intercrops couldn't have any significant influence on the plant height of maize

(Table 1). Even though the differences were non-significant, the taller maize plants were observed in sole cropping as compared to intercropping treatments. The maximum plant height of 239 cm and the lowest of 227 cm were observed in sole maize and maize inter cropped with cluster bean, respectively.

The data on number of leaves per plant of maize indicated that, different treatments tried in the experiment could equally influence the number of leaves per plant (Table 1). The least number of leaves (10) were registered in maize intercropped with pillipesara and cluster bean treatments where as the highest number (11.3) were found in sole maize treatment.

Drymatter accumulation

Total drymatter yield and legume drymatter were significantly affected by different intercropping treatments whereas, the drymatter yield of maize was not affected by treatments (Table1). Higher drymatter accumulation was recorded with sole crops of legumes over their respective intercropped stands. Among the different sole fodder legumes, cowpea registered the highest drymatter accumulation (2701 kg ha^{-1}) while lowest was recorded with pillipesara. Cowpea is superior to other legumes because it tolerates both drought and shade. Reductions of drymatter in legumes was observed in mixed intercropping compared to row intercropping in between the fodder maize pairs. The reduction in legume drymatter in mixed cropping might be due to increased population pressure and inter-specific competition. Legume fodders intercropped within the pairs of maize recorded better performance with lower reduction in drymatter. This might be due to better utilization of environmental resources and the availability of ample space between paired rows. The highest total drymatter of 9205 kg ha^{-1} was recorded in maize pairs + cowpea and was followed by 8694 kg ha^{-1} in maize pairs + cluster bean. The lowest total drymatter accumulation (7205 kg ha^{-1}) was recorded in maize + pillipesara mixed cropping and this was statistically comparable with total drymatter accumulation (7622 kg ha^{-1}) in maize sole cropping. This might be due to better utilization of space and light interception coupled with nutrient contribution of legume fodder to cereal. Intercropping offered more plants per unit area and efficient utilization of environmental and soil resources which might have resulted in higher drymatter accumulation. These findings are in agreement with reports of Kumar and Prasad (2003)and Eskandari and Ghanbari (2009).

Green fodder yield

Green fodder yield of maize var. African tall was influenced by treatments. Green fodder of 40 t ha^{-1} was registered in sole maize fodder and was followed by 38 t ha^{-1} in Maize pairs+ Pillipesara and maize pairs+ cluster bean. The lowest green fodder yield (35 t ha^{-1}) was observed in Maize + Cow pea mixed treatment. The data indicated that all legumes when sown in sole situation, performance better. It was also evident from data the legume fodders registered better yields when they were inter cropped in maize fodder pairs over mixed intercropping with fodder maize. The highest legume fodder was recorded in sole cowpea with 20.8 t ha^{-1}. Significantly the lower green fodder yield was recorded by pillipesara (0.6 t ha^{-1}) in T_6 treatment. Performance of leguminous fodder was in the order of cowpea, cluster bean and pillipesara in sole situation, maize pairs + legumes and maize + legume mixed intercropping .

Total fodder yield of maize + legume mixture which is a true indicator of real output recorded was higher under intercropped situation compared to sole crops of either fodder maize or fodder legumes. However, intercropping of all the legumes in between maize pairs registered higher total fodder yield over mixed intercropping of fodder maize and fodder legumes.The highest mixed fodder yield was obtained from cowpea seeded in paired rows of maize (50.1 t ha^{-1}) followed by maize pairs + clusterbean intercropping (46.9 t ha^{-1}). Contrarily the lowest mixed fodder yield was recorded for maize + pillipesara mixed intercropping treatment (36.6 t ha^{-1}).

In general, forage yield of the component crops, viz., maize, cowpea, pillipesara and clusterbean in intercropping decreased in comparison to their respective sole stands. The higher yield in sole stands might be due to limited disturbance of the habitat and interactional competition in the sole cropping environment. Under sole cropping crop didn't experience inter-specific

Table 1. Plant height, No. of leaves and Drymatter yield as influenced by different treatments.

Treatments	Plant height (cm)	No. of leaves per plant	Drymatter yield (kg ha^{-1})		
			Maize	legumes	Total
Sole fodder maize	239	11.3	7622	-	7622
Sole cowpea	-	-	-	2701	2701
Sole pillipesara	-	-	-	1907	1907
Sole clusterbean	-	-	-	2557	2557
Maize + cowpea	229	10.3	6904	442	7346
Maize + pillipesara	230	10.0	7133	72	7205
Maize + clusterbean	227	10.0	7067	303	7370
Maize in pairs + cowpea	231	10.6	7506	1699	9205
Maize in pairs + pillipesara	234	10.7	7504	151	7655
Maize in pairs + clusterbean	237	10.7	7533	1161	8694
Sem±	15	0.6	414	79	382
CD (P=0.05)	NS	NS	NS	237	1136
CV (%)	11	9.0	10	11	11

competition as in case of intercropping treatments. These results are in conformity with the findings of Ayenhbad and Behrooz (2011). But this decrease was compensated by contribution of both components in total intercrop yield. The increase in total green fodder in intercropping system might be owing to better utilization of space and light interception along with nutrient contribution of leguminous fodder to cereal. These results are in line with findings of Nyamagonda (2002) , Sharma (2008) and Surve*et al.*(2011).

Dry fodder yield

Even though the dry fodder yield of fodder maize was uninfluenced by treatments relatively higher yield (11.9 t ha^{-1}) was registered in sole maize treatment and relatively the lowest yield was observed in fodder maize when mixed with cowpea (10.4 t ha^{-1}). Dry fodder yield of legume was significantly influenced by different treatments tried. Performance of the leguminous fodders in the sole cropped situation was highest followed by intercropping them in fodder maize pairs. The least performance could be observed when legumes were mixed intercropped with fodder maize. Significantly total dry fodder yield (4.78 t ha^{-1}) was recorded in cowpea sole crop and was statistically comparable with sole clusterbean (4.52 t ha^{-1}). Significantly the lowest dry fodder yield 0.13 t ha^{-1} and 0.27 t ha^{-1} was recorded by pillipesara mixed intercrop and paired intercropping respectively.Total dry fodder yield was the highest (14.2 t ha^{-1}) under maize in pairs + cowpea intercropping system followed by maize in pairs + clusterbean intercropping (13.4 t ha^{-1}). It is reasonable to suggest, two species of contrasting habit with respect to branching, leaf distribution, height, root distribution, mineral uptake or other morphological or physiological characters, will together be able to exploit the total environment more effectively over monoculture, and will thereby give increased overall yield. Hence fodder maize intercropped with cowpea could result in the higher dry fodder yield. Similar results of increased fodder yields in fodder maize intercropped with cowpea was also reported by Kumar and Prasad (2003).

Economics

The highest gross return (Rs. 28,448) was recorded by maize in pairs + cowpea intercropping treatment which was statistically comparable with maize in pairs + clusterbean intercropping treatment

Table 2. Green and dry fodder yield (t ha^{-1}) of maize and legume intercrops as influenced by different treatments.

Treatments	Green fodder yield (t ha^{-1})			Dry fodder yield (t ha^{-1})		
	Maize	Legumes	Total	Maize	Legumes	Total
T :Sole fodder maize	40.0	-	40.0	11.9	-	11.9
T^{1}:Sole cowpea	-	20.8	20.8	-	4.8	4.78
T^{2}:Sole pillipesara	-	14.7	14.7	-	3.4	3.37
T^{3}:Sole clusterbean	-	19.7	19.7	-	4.5	4.52
T^{4}:Maize +cowpea	35.0	3.4	38.4	10.4	0.8	11.1
T^{5}:Maize + pillipesara	36.0	0.6	36.6	10.7	0.1	10.8
T^{6}:Maize +clusterbean	35.0	2.3	37.3	10.6	0.5	11.1
T^{7}:Maize in pairs + cowpea	37.0	13.1	50.1	11.2	3.0	14.2
T^{8}:Maize in pairs + pillipesara	38.0	1.2	39.2	11.3	0.3	11.6
T^{9} :Maize in pairs + clusterbean	38.0	8.9	46.9	11.3	2.1	13.4
SEm^{10}±	2.2	0.6	2.1	0.7	0.1	0.7
CD(P=0.05)	NS	1.8	6.2	NS	0.4	2.1
CV(%)	11.0	11.0	10.6	10.6	11.3	10.3

Table 3. Gross return, Net return and Return per rupee investment as influenced by different treatments.

Treatments	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	Return per rupee investment
T :Sole fodder maize	19760	8495	1.8
T^{1}:Sole cowpea	15583	4968	1.5
T^{2}:Sole pillipesara	11000	1785	1.2
T^{3}:Sole clusterbean	14750	4785	1.5
T^{4}:Maize +cowpea	19810	6445	1.5
T^{5}:Maize + pillipesara	18251	5986	1.5
T^{6}:Maize +clusterbean	19417	6702	1.5
T^{7}:Maize in pairs + cowpea	28448	14783	2.1
T^{8}:Maize in pairs + pillipesara	19633	7068	1.6
T^{9} :Maize in pairs + clusterbean	25533	12518	2.0
SEm^{10}±	1120	782	0.09
CD(P=0.05)	3326	2322	0.3
CV (%)	10	18	10.0

with a gross return of Rs.25,533 (table 3). Significantly the lowest gross return (Rs. 11,000) was obtained from sole pillipesara. The highest net return (Rs.14,783) and returns per rupee investment (2.1) were recorded in maize in pairs + cowpea intercropping treatment which was statistically comparable with maize in pairs + clusterbean intercropping treatment. This could be due to the high green fodder yield in these treatments. The lowest gross returns (Rs.11000), net return (Rs.1,785) and returns per rupee investment (1.2) were registered in sole pillipesara treatment. These results are in accordance with Ramanakumar and Bhanumurthy (2001).

The present experimement revealed that sowing fodder maize in paired rows with cowpea as intercrop was advantageous which resulted in higher total green fodder yield and monetary returns.

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